

DEVELOPMENT OF POWER TILLER OPERATED HARVESTER, FOR SMALL ONION (*ALLIUM CEPA* VAR. *AGGREGATUM*)

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ABSTRACT

Harvesting of the small onion crop from the field is an important operation, in the cultivation of a small onion. In our country, few models of small onion harvesters are developed in which, damage of bulbs is more, so it is not used by farmers. Non-availability of matching equipment for different farm operations limits the versatility of power tillers. Hence a small onion harvester was developed as an attachment to power tiller which will increase the annual usage of power tiller in the farmers holding in addition to make the power tiller a versatile power source. The performance of power tiller operated small onion harvester was field tested for harvesting CO (On) 5 varieties. The field capacity was found to be 0.08 ha h⁻¹. The cost of harvesting with the small onion harvester was Rs. 918/- ha⁻¹. The saving in cost and time were 59.2 and 93.75 per cent respectively as compared to the conventional method of manual harvesting. The break-even point (BEP) of the small onion harvester costing Rs. 9000 was 60.13 h of operation per annum. The harvesting, conveying and soil separation efficiency of the developed harvester is 97.4, 86.9 and 84 per cent.

KEYWORDS: Harvesting, Small Onion, Power Tiller, Digging Tools, Evaluation & Field Capacity

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INTRODUCTION

Small onions are also known as shallots, multiplier or aggregatum onion. This onion is produced only in the southern states of India viz., Tamil Nadu, Andhra Pradesh and Karnataka. In India, onion is the fourth most important commercial vegetable crop covering an area of 5.93 lakh hectares, which is 10 percent of the total vegetable area and is highly valued. There is a lot of demand of Indian Onion in the world, the country has exported 14, 82,498.58 MT of fresh onion to the world, worth of Rs. 3,169.63 crores, during the year 2013-14. (Indian Horticulture Database, 2011). CO (On) 5 is the highest yielding variety, with attractive pink and bold bulbs; it is a free- flowering type with seed setting ability (Pandiselvam *et al*, 2013).

Harvesting is done by pulling out plants when tops are drooping but still green. The height of the small onion crop during harvesting is 15-40 cm and the crop stem diameter is 1-2 cm. The number of shoots per plant is 10-15. During hot days when the soil is hard, bulbs are pulled out with a hand-hoe. The production of small onion is 12-16 tonnesha⁻¹ in 70 to 90 days. The bulbs are cleaned and dried for 4 days in shade soon after harvest.

Manual harvesting of onions is a tedious, time consuming, labor intensive and costly operation so mechanization of harvesting is essentially needed. Mechanization of onion harvesting needs as traditionally, the well-matured bulbs are harvested by hand shovel (khurpa) which requires 21.4 per cent of total expenditure of onion cultivation (Ashwini *et al*, 2014). About 12.5 man hours are required in manual detopping operation of 1 MT

onion bulbs. Hence, mechanical detopping is required. Also, it is necessary to complete the harvesting operation within specified time limits, for reducing harvest losses and increasing storage life. In fact, early harvesting affects the keeping quality of onions adversely and reduces the yield, whereas delayed harvesting leads to infection caused by microorganisms. Harvesting of small onion (*Allium cepa* var. *aggregatum*) is more labor intensive and also bulb damage is higher during harvesting.

MATERIALS AND METHODS

The power tiller of 8-13 hp is used as a power source for the developed small onion harvester. In all the field tests the small onion harvester was operated in the low first gear by keeping the accelerator lever in a specific position for achieving the forward speed in the range of 1 to 2 kph. The average fuel consumption recorded was 1.2 lhr⁻¹.

1:	Rotary gear box
2:	Tool mounting frame
3:	Tool
4:	V-belt and pulley mechanism
5:	Conveying roller
6:	Conveyor belt
7:	Digging bars
8:	Levelling roller
9:	Conveyor mounting frame
10:	Conveyor bars
11:	Side flange

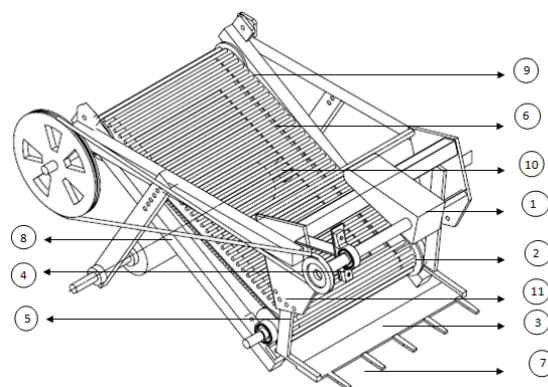


Figure 1: Components of Small Onion Harvester

The components of the developed small onion harvester are

- Mainframe
- Side flange
- Conveyor mounting frame
- Digging tool
- Conveyor assembly
- Drive for the conveyor
- Levelling roller

Main Frame

M. S channel of $40 \times 40 \times 6$ mm was used for the fabrication of the main frame. Frame of size $820 \times 650 \times 40$ mm was made and attached at the center of the rotary gear box of the power tiller. A provision was given in the main frame to adjust the distance between the tool and the conveyor mechanism.

Side Flange

The side flanges of size $340 \times 200 \times 10$ mm were made by M. S flat which was attached to the main frame by nuts bolts. Three holes were provided on the side flanges to adjust the rake angle at different levels.

Conveyor Mounting Frame

Conveyor mounting frame of size $850 \times 570 \times 40$ mm was made by M. S channel of $40 \times 40 \times 6$ mm. It was attached to the side flanges with the help of nuts and bolts and also a chain connecting with main frame was provided on side flanges in order to adjust the position of the conveyor.

Digging Tool

The tool was mounted to the tool mounting frame with the help of screws for its easy replacement. The thickness of the tool was 12 mm. The front edge top face of the tool was tapered to have a taper angle of 15 deg in all the tools (Gupta *et al.*, 1989). The tool consists of five flat bars having length of 75 mm and thickness of 15 mm which is used to open the land at first and helps in better digging of small onion crop without damage. The depth of operation of the tool was maintained at 100 mm for all the experiments within which all the bulbs remain in the soil (Daniel Sundarraj and Thulasidas, 1993).

Conveyor

The conveyor was made of canvas belt of 61×13 mm size and conduit rods of 10 mm size. The conveyor consisted of two shafts mounted on self-aligned bearings fixed apart at a center distance of 500 mm. The belt runs on two hollow rollers of 76 mm diameter and 480 mm length. The rods were riveted on both the ends in the belt using M. S rivets. The spacing between rods was 150 mm. The number of rods used in conveyor was 72. The angle of conveyor in small onion harvester was given based on the angle of repose of small onion seeds which was 28.11 to 37.41° (Pandiselvam *et al.* 2013).

Drive for the Conveyor

The power was taken from the rotary gear box of the power tiller. From the rotary gear box, the power was transmitted to the shaft of the small onion conveyor unit through B type V-belt and pulley mechanism. The driver pulley was mounted on the shaft of the gearbox of power tiller. The diameter of the driver pulley was kept at 100 mm and that of the driven pulley as 300 mm so as to get the required speed of the conveyor mechanism.

Levelling Roller

A leveling roller of 115 mm diameter and 470 mm length was provided for leveling the harvested area. The leveling roller was attached to the main frame using two side flanges of $520 \times 50 \times 25$ mm. The flange consists of six holes of 12 mm diameter at a distance of 12 mm was provided for length adjustment. The roller helps with easy transport of harvester outside the field. It was also used for controlling the depth of operation in the levelled surface only, the harvested

small onion falls on the leveled surface. The leveler was used to level the field continuously after harvesting.



Figure 2: Developed Power Tiller Operated Small Onion Harvester

Table 1: Specifications of Developed Power Tiller Operated Small Onion Harvester

1	Name	Small onion harvester
2	Source of power	Power tiller
3	Overall dimensions (L × B × H), mm	1120 × 740 × 560
4	Width of operation, mm	530
5	Depth of operation, mm	100
6	Digging tool dimensions (L × B × H), mm	530 × 150 × 7
8	Length of conveyor, mm	725
9	Width of conveyor, mm	480
10	Diameter of conveyor bars, mm	100
11	Conveyor angle, degrees	28
12	Spacing between conveyor bars, mm	100
13	Number of conveyor bars, mm	72
14	Weight of small onion harvester, kg	95 kg
15	Conveyor speed, m s ⁻¹	1.3
16	Cost of the unit, Rs.	9000

RESULTS

Field Performance Test

The power tiller operated small onion harvester was tested for harvesting CO (On) 5 varieties at the Agricultural Machinery Research Centre, Coimbatore. The field was prepared with bed width of 500 mm. The spacing used was 200×150 mm and a furrow of 400 mm width was provided between the beds for irrigation purpose as well as for the mobility of the wheel of the power tiller. The implement was hitched to the rotary gear box unit of the power tiller. The engine speed of the power tiller was adjusted for 1.5 kph forward speeds by selecting the appropriate transmission ratio and by adjusting the engine throttle lever. The observations were made for three replications and data's were recorded. The small onion harvester was operated in the field to harvest 0.5 ha in CO (On) 5 and the performance was evaluated. The following field tests were carried out to study the performance of the small onion harvester in terms of field capacity, fuel consumption and draft.

Table 2: Field Performance Data's of Small Onion Harvester

S. No	Parameter	Values
1	Harvesting efficiency, per cent	97.4
2	Conveying efficiency, per cent	86.9
3	Soil separation efficiency, per cent	84
4	Conveyor loss, per cent	2

Table 2: Contd.,		
5	Theoretical field capacity, ha h ⁻¹	0.075
6	Effective field capacity, ha h ⁻¹	0.062
7	Field efficiency, per cent	82.6
8	Fuel consumption, l h ⁻¹	1.2

CONCLUSIONS

The requirement of labor for manual harvesting of one hectare of small onion crop was 15 woman days. The cost of harvesting was Rs.2250 per ha at the prevailing wage rate of Rs.150 per labor per day. From the field capacity of the unit, the cost of operation per ha was calculated as Rs.918 /-. Comparing harvesting of small onion using power tiller operated small onion harvester with manual harvesting, 59.2 per cent of cost and 93.75 percent of time is saved. The break-even point (BEP) of the power tiller operated small onion harvester was 60.13 h per annum and 4.8 years. The developed small onion harvester worked well during the field test.

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